Improved economic stimulation mechanism to reduce vehicle CO_2 emissions

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Abstract

One of the major problems associated with the negative environmental impact of vehicles is the significant level of CO_2 emissions. The increasing concentration in CO_2 in the atmosphere as a result of vehicle emissions is accompanied by both an increase in the consumption of petroleum fuels, which have limited resources, and global climate change. The aim of this work is to improve the mechanism of economic stimulation to reduce CO_2 emissions from vehicles through changes in the system of taxation of oil products. Analytic investigation by the authors and the systematization of the main methods of reducing vehicle CO_2 emissions have revealed the required government direction to improve the economic management of their implementation and the necessity for priority stimulation to produce and consume fuel that is more environmentally acceptable. One effective instrument for such stimulus is an improved method of taxing oil products through the introduction of a new tax which takes into account the level of CO_2 emissions from fuel combustion while also taking state measures to limit the growth in prices for gasoline and diesel fuel. The authors have found the dependence of vehicle CO_2 emissions on the qualitative characteristics of consumed fuel (gasoline and diesel) and have substantiated a methodological approach to the tax calculation.
Keywords: CO_2 emission, economic stimulation, oil tax system, vehicle.

1 Introduction

Auto transport, which numbers over a billion units across the world, is one of the major consumers of oil products and, as a consequence, one of the utmost emitters of CO_2. Consumption of fuel and energy resources is one of the main


WIT Transactions on The Built Environment, Vol 130, © 2013 WIT Press
www.witpress.com, ISSN 1743-3509 (on-line)
doi:10.2495/UT130391

indicators of level of civilization. Rapidly developing economies require increasing the consumption of energy resources. In today's context of increasing natural resource scarcity and assimilating capacity of the environment, there is a strong need to elaborate and implement mechanisms for optimal use of the resources and to find the means to ensure sustainable, environmentally balanced economic development of the society, taking into consideration the interests of future generations. In this context, the search for new ways to reduce CO_2 emission from vehicles in association with an increase in the consumption of scarce petroleum fuels is a topical problem.

According to assessment of the International Energy Agency [1] the priority direction of reducing of carbon dioxide emissions is an increase of vehicle's fuel efficiency, where the determining role belongs to fuel quality enhancement. The introduction of an effective economic stimulus for petroleum producers is one of the ways to resolve the problem.

2 Vehicles as a CO_2 emission source

Auto transport consumes over 2 billion tons of motor fuel per year and their burning causes a big part of CO_2 emission in atmosphere. In the structure of CO_2 fuel combustion emissions in the world and in the Russian Federation the vehicles share is 16.4 and 8.8% respectively (table 1).

Table 1: CO_2 fuel combustion emissions in the world and in the Russian Federation sectors of the economy, 2010 [2].

№	Sector of the economy	In the world		In the Russian Federation	
		CO_2 emission, mln.t.	Unit weight, %	CO_2 emission, mln.t.	Unit weight, %
1	Power industry	12,480.6	41.2	832.6	52.7
2	Industrial production and construction	6,186.4	20.4	294.3	18.6
3	Transport, including:	6,755.8	22.3	242.1	15.3
3.1	automobile transport	4,972.1	16.4	139.9	8.8
4	Other sectors	1,570.8	5.2	63.2	4.0
5	Other	3,282.6	10.8	149.2	9.4
Total		30,276.1	100	1,581.4	100.0

Having calculated the contribution of the transport sector in the global CO_2 emissions, the International Energy Agency has evaluated the share of transport in reduction of petroleum consumption in frame of the most optimistic of scenarios for accelerated technology development (Accelerated Technology scenarios) by 2050 is equal to 62% (Fig. 1) [1, 3].

It should be noted that the continuing rapid growth of the vehicle fleet alongside the almost unchanging quality of fuel consumed in Russia concurs with a proportional increase in CO_2 auto transport emissions.

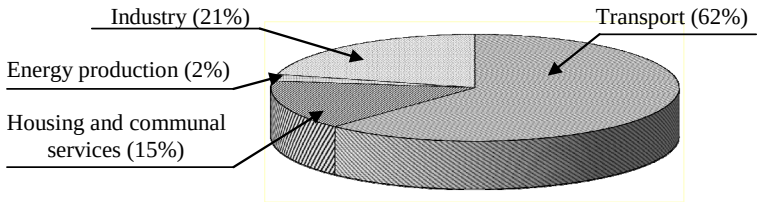

Figure 1: Reduction of oil consumption by the year 2050.

Table 2 shows data on vehicle fleet growth in Russia in the period from 2000 to 2011.

The results of negotiations among member countries of the UN Framework Convention on Climate Change which took place on Climate Change Conferences [4], economic mechanisms of the Kyoto Protocol and methodologies of greenhouse gases inventory [5–8] were analyzed. It led to the conclusion that nowadays the Kyoto Flexibility Mechanisms can be efficiently applied only to stationary sources of CO_2 emissions (plants). It is difficult to obtain accurate data on emission produced by mobile sources, including vehicles, because of the difficulties in obtaining data for calculation. Hence, it is impossible to apply economic mechanisms of the Protocol effectively.

Table 2: Vehicle fleet dynamics in Russia, in thousands of units [9].

№	Item	Years							
		2000	2005	2006	2007	2008	2009	2010	2011
1	Motor trucks	4,401	4,848	4,929	5,168	5,349	5,323	5,414	5,545
2	Buses	640	792	824	882	894	896	894	902
3	Cars	20,353	25,570	26,794	29,405	32,021	33,084	34,354	36,415
	Total	25,394	31,210	32,547	35,455	38,264	39,303	40,662	42,862

It determines the need for substantiation of alternative mechanisms of reducing auto transport consumption of scarce hydrocarbon fuels.

3 Means of reducing CO_2 vehicle emissions

In accordance with the optimistic scenario by the BLUE Map, the International Energy Agency estimated that by increasing fuel efficiency it is possible to reduce 74% of carbon dioxide emissions produced by the transport sector while another 26% can be reduced by the use of alternative fuels (Fig. 2) [1, 3].

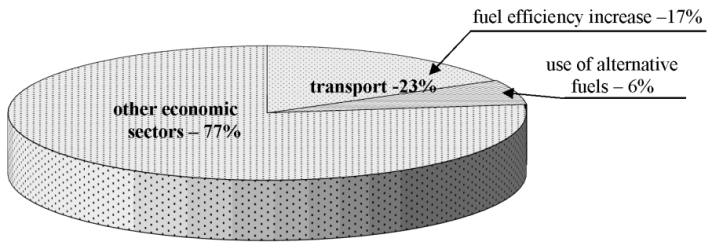

Figure 2: Share of transport in global CO_2 emission reduction.

Figure 3 shows a systemized means of reducing CO_2 vehicle emissions, which are divided into 2 groups. The first group is an increase of fuel efficiency of vehicles with gasoline and diesel engines. The second group is consumption of fuels and energy which are considered an alternative to traditional oil fuels (gasoline and diesel fuel) and energy.

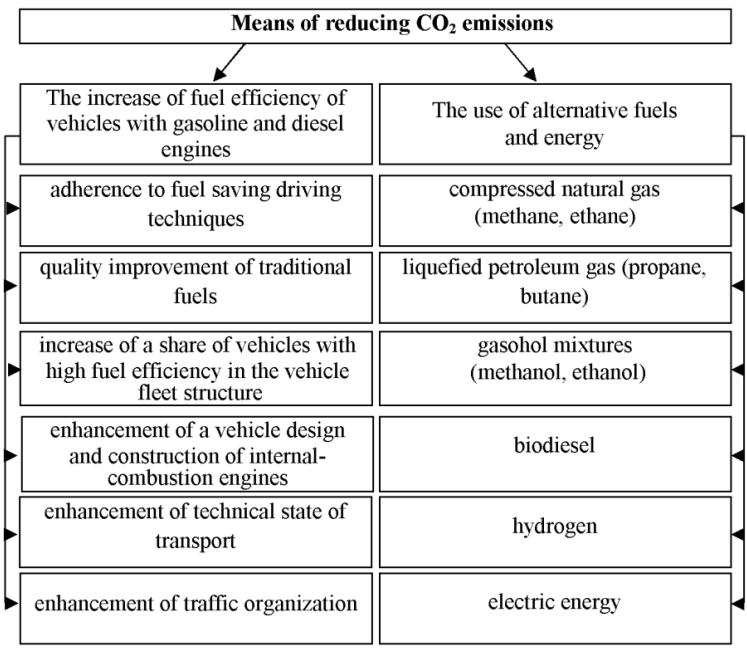

Figure 3: Means of reducing CO_2 vehicle emissions.

It should be observed that among the discussed means of fuel efficiency increase in Russia the main one is the quality increase of gasoline and diesel

fuels [10–12]. The analytical studies carried out by the authors revealed the main factors of fuel efficiency increase of automobile transport with gasoline and diesel engines (Fig.4).

The goal of CO_2 emission reduction by vehicle fuel efficiency increase is one of the priorities for the international community, given the existing need for an efficient use of nonrenewable energy resources.

The systematization of revealed operational methods of CO_2 transport emission reduction was made, which allowed us to determine instruments of reducing greenhouse gases transport emissions by implementing economic stimulation of parties involved in the transportation process. These instruments are alternative to those stated in the Kyoto Flexibility Mechanisms (table 3).

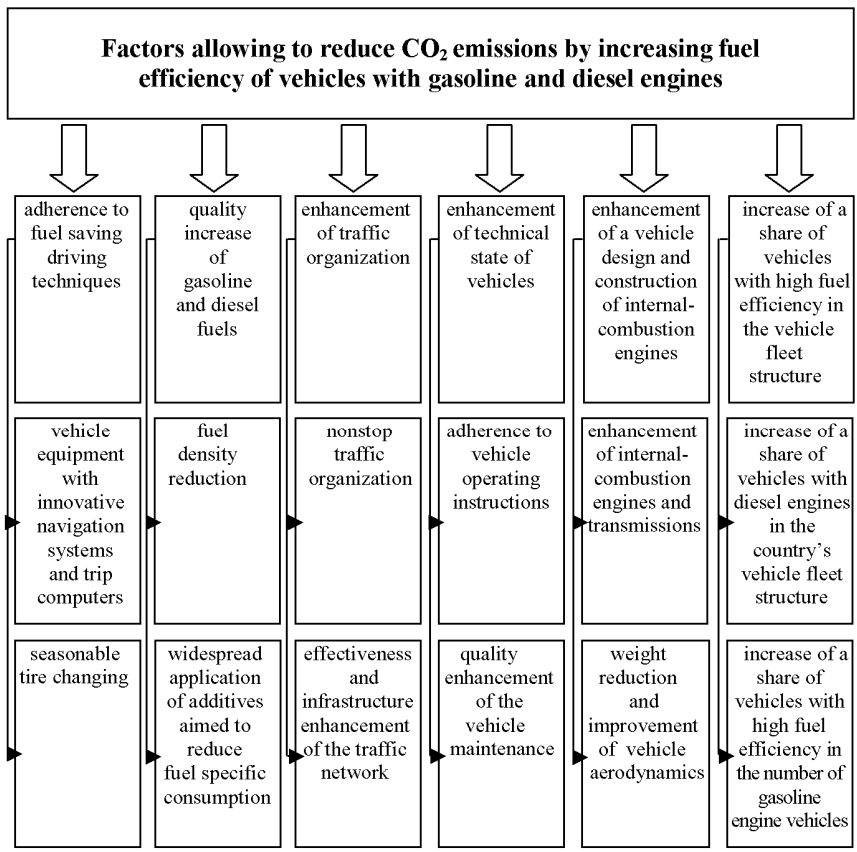

Figure 4: Factors allowing for reduction of CO_2 emissions by increasing fuel efficiency.

Table 3: Instruments of economic stimulation for reducing CO_2 emissions towards responsible parties.

Party	Direction of stimulation for reducing CO_2 emissions	Instrument	Remarks
CAR OWNERS (individuals and automobile companies)	Stimulation of adherence to fuel saving driving techniques	finance and credit mechanism	introduction of fines for neglecting the rules of seasonable tire change
		government support	financing of development and introduction of new technologies in the sphere of applying intelligence retrieval systems and trip computers
			road network construction and reconstruction of transportation systems aimed to ensure nonstop traffic organization
		pricing policy	preferential pricing on innovative navigation systems and trip computers
	Stimulation of adherence to vehicle operating instructions	finance and credit mechanism	introduction of fines for undue vehicle maintenance
		taxation	graduated tax upon car owners depending on vehicle operation life
	Stimulation of purchase of vehicles with high fuel efficiency, among them vehicles running on alternative fuels and energy	government support	old vehicles utilization program
		pricing policy	preferential pricing on vehicles with high fuel efficiency, among them vehicles running on alternative fuels and energy
		taxation	preferential taxation for automobile companies with high fuel efficiency vehicles in the vehicle fleet structure, among them vehicles running on alternative fuels and energy
CAR MANUFACTURERS	Stimulation of development and production of enhanced internal-combustion engines and vehicles with advanced construction	finance and credit mechanism	preferential crediting of measures aimed to develop technologies of enhancing internal-combustion engines and vehicle design, among them transition of vehicles on alternative fuels and energy
		government support	introduction of environmental subsidies to developers and producers of high-tech internal-combustion engines, vehicle design allowing to increase fuel efficiency, among them vehicles running on alternative fuels and energy
	Stimulation of keeping of allowed CO_2 emissions level for manufactured vehicles	taxation	tax on vehicle CO_2 emissions
		environmental certification system	enforcement of allowed CO_2 emissions level on an average in a corporation/ differentially on vehicles

Table 3: Continued.

Party	Direction of stimulation for reducing CO_2 emissions	Instrument	Remarks
FUEL PRODUCERS	Stimulation of producing fuels with lower CO_2 emission level	finance and credit mechanism	preferential crediting of new refineries construction
		government support	oil processing modernization
		pricing policy	government limitation of price increase on motor fuel
		taxation	tax aimed to reduce CO_2 emissions from fuel combustion
		environmental certification system	introduction of a index in fuel quality certificates, indicating its CO_2 emission level release while combustion (fuel density can be taken as such index)
	Stimulation of alternative fuels and energy production	finance and credit mechanism	preferential crediting and investment subventions for fuel producers developing and producing alternative fuels and energy
		government support	support of development and production of alternative fuels and energy
	Stimulation of application of additives aimed to reduce fuel specific consumption	government support	support of developers and producers of additives aimed to reduce fuel specific consumption
		environmental certification system	prescribing an obligatory use of additives in standards and technical regulations

4 Improvement of the oil products taxation system as a means of CO_2 emission reduction

4.1 Substantiation of the need to levy a new oil products tax in Russia which is aimed at reducing CO_2 emissions from fuel combustion

The quality of Russian vehicle fuels is established in Technical Regulations on requirements for automotive and aviation gasoline, diesel and marine fuel, jet fuel and heating oil, approved by RF Government Decree № 118 of 27 February 2008 [13]. The Regulations contain the gradation of vehicle gasoline and diesel fuels incorporating four environmental categories that determine excise tax rates since 1 January 2011 [14]. The Regulations establish mandatory requirements to motor fuels, according to which "Euro-2" fuels shall be withdrawn from production starting from 1 January 2013, "Euro-3" fuels – from 1 January 2015, "Euro-3" fuels – from 1 January 2015 [13]. However, nowadays transition to the Technical Regulations requirements to fuel quality is substantially behind

schedule. Russia's WTO entry will, to a certain extent, favor the more rapid modernization of oil processing in accordance with the government program.

Nowadays, the fiscal burden of Russia's oil industry is the heaviest in comparison to taxation systems in other oil producing countries. More than half of the national budget in Russia is formed by tax proceeds from the oil industry. The budget message set the task of improving taxation mechanisms in the sector to develop new deposits and, more importantly, to develop deep oil refining.

In Russia, taxes account for over 50% of the price of gasoline in comparison with gasoline prices in the US, where they depend mainly on the exchange quotations because the oil price makes up around 70% of the gasoline price. It has to be taken into consideration that in Russia, where the oil products' market is quite monopolistic, the price is determined, to a large extent, by arrangements set by the oil producers.

The enhancement of the oil taxation system along with taking contemporaneous measures of the government's limitations on oil prices can be an effective method of economic stimulation of environmentally friendly fuel production and consumption in the Russian Federation.

The main taxes which form a motor fuel price in Russia are the excise, the income tax, the value-added tax and the tax on mining operations. From all the taxes mentioned above only the excise depends on the motor fuel quality (from 1 January, 2011) because the existing rates depend directly on the environmental category of gasoline or diesel fuel. The analysis of the existing oil taxation system has shown that today's oil taxes in Russia, as well as in the rest of the world, are not connected with carbon dioxide emissions, therefore, they do not stimulate producers to reduce them. Although the excise existing in the Russian Federation depend on environmental characteristics of the fuel, they do not depend on the amount of CO_2 emissions that are discharged in the burning process because fuels within a qualitative category can substantially differ in CO_2 specific emission.

Taking into account that:

- the main CO_2 emission source is fossil fuel combustion, one of the main consumers of which is automobile transport;
- one of the most effective instruments of pressure on the fuel producers is tax stimulation;
- fuel taxes nowadays do not depend on CO_2 emissions,

It is necessary to improve the existing oil taxation system by introducing a new tax that would depend on CO_2 emissions from fuel combustion. It is worth mentioning that introducing the new tax without government control over pricing, will lead to an increase in car fuel price and will stimulate consumers to buy fuel of higher quality instead of motivating producers to improve its quality.

4.2 Methodological approach to calculating a tax depending on CO_2 emission from fuel combustion

The fuel quality and the CO_2 emission from fuel combustion are, to a large extent, determined by fuel density which is an easily estimated and controlled

indicator of quality of the oil product. Decrease in fuel density within a certain quality class does not require additional investments and is determined by the temperature range of grading gasoline and diesel content during the oil refining process [10, 11]. Considering direct linear dependence of the CO_2 emission from fuel density [10, 11], it is possible to introduce a tax on the motor fuel density which would supplement the existing taxation. This tax is reasonable to levy on produced fuels without taking into account the oil products which are the semi-products for further processing of the fuel into commercial grade fuel. Thereby, the suggested tax on motor fuel density should be an indirect tax levied in addition to the excises on oil products.

The formula of calculating the tax on motor fuel density (1) is the following:

$$T = P_{CO_2} \cdot \left(G_{CO_{2i}} - G_{CO_{2i\,\min\rho}} \right) \quad (1)$$

where T is a tax rate on motor fuel density; P_{CO_2} is the value of the CO_2 emission quota on the global carbon market; $G_{CO_{2i}}$ is CO_2 emission from combustion the i-type motor fuel (gasoline or diesel fuel) sold by the oil refiners, ton per fuel ton; $G_{CO_{2i\,\min\rho}}$ is CO_2 emission from combustion the i-type motor fuel (gasoline or diesel fuel) of minimum density, ton per fuel ton.

It should be mentioned that the suggested method of enhancing the oil product taxation system can be applied both in Russia and in other countries.

5 Conclusion

The enhancement of the existing world oil products' taxation systems by introducing a motor fuel density tax along with government measures aimed to limit the increase in prices will enable a decrease in the consumption of scarce hydrocarbon fuels, as well as reducing CO_2 emissions from road transport and improving the environment in megalopolises.

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